World Applied Sciences Journal 13 (9): 2027-2031, 2011
ISSN 1818-4952

GIS-Based Process Used to Determine the Locations of Ecotourism Sites Based on Climatic Variables

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Abstract: The ecotourism is based on natural attractiveness, but it has important effects on economic development. The Noshahr-Chalous region is one of the best-known environmental conditions for ecotourism activities. Ecotourism projects would need to identify suitable regions. In this study, the suitability of ecotourist sites has been carried out on the basis of natural and ecological ability and classified into three classes: suitable, semi suitable and unsuitable. Raster and vector data and GIS technique are used for analysis. The GIS data of this research are related to warm seasons. After that analysed by GIS, indeed the suitable, semi suitable and unsuitable sites have been scattered in high, middle and low elevations with regard to tourism ecological model, respectively.

Key words: Iran · Noshahr-Chalous · Ecotourism · GIS · Suitability

INTRODUCTION

Ecotourism is a major branch of tourism study, which is based on natural phenomenon. Thus, the recognition of ecotourism potential is necessary for each region. Many techniques have been employed to identify of these regions, but, GIS methods are more effective for better determination of these regions. [1] Abdus salam et.al (2000) believed that the GIS, satellite's imagery and information technology (IT) are useful for protecting of Mangrove Sandarban forest's resources, plant and animal life in order to tourism development. [2] Fung and Marfa (2002) has introduced Feng Shui woodlands as a cultural heritage and believed that it can be very important in Hong Kong ecotourism. They have suggested that GIS plays a major role in developing of tourism whit the use of satellite images. [3] Gaughan *et al.* (2009) described the value and changes of forest whit the use of multi temporal Landsat imagery and also they play up the role of GIS on forest resources suitability for developing of tourism of Angkor basin. [4] Kumari *et al.* (2002) clearly identified the potential ecotourism sites and then prioritized them by using wildlife distribution index (WDI), ecological value index (EVI), ecotourism at tractability index (EAI), environmental resiliency index (ERI), ecotourism diversity index (EDI), GIS and RS in West District Sikkim. [5] Othman *et al.* (2010) believed that Geographic Information System (GIS) is a useful tool for managing, storing, analyzing and also invaluable in visualizing the spatial and non-spatial data. They have suggested that outcomes of GIS analysis cleary demonstrate the spatial visualization of the lodging evolution and geographical distribution trends in the east coast states of Malaysia [6]. Pyngnga (2008) in his paper entitled "ecotourism prioritization: a geographic information system approach" emphasized the role of GIS in multi criterion decision-making as a solution the problems of spatial multi objective based on ranking and prioritizing of tourist sites. He believed that mentioned technique can allocate the credits based on prioritize. [7] Yacob *et al.* (2009) in order to contingent valuation of ecotourism in marine parks, Malaysia by use of CV methods, suggested that visitors are willing to pay for conservation fee about RM7.8 and RM10.6 per visit for local and international visitors. They believed that the results of this study are very important in assists policy makers in management and operation for marine parks ecotourism especially on revenue mechanism.

In this paper, the aim is to identify potential ecotourism sites in Noshahr-Chalous region by using GIS technique. It is important to recognize of ecotourism abilities and the use of necessary devices by responsibilities that can led to job opportunities and economic development.

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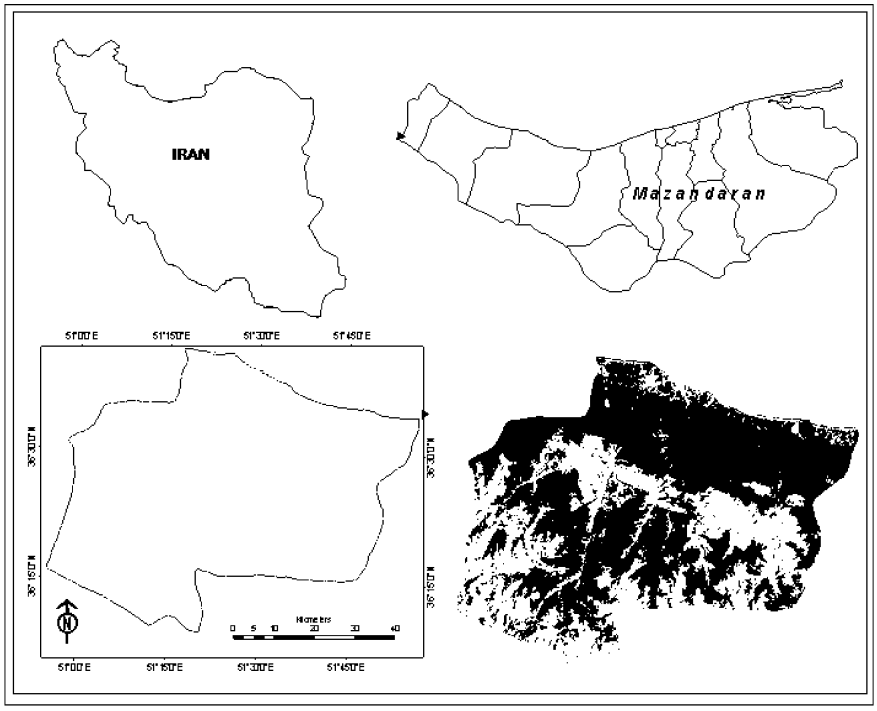

Fig. 1: Location of study area

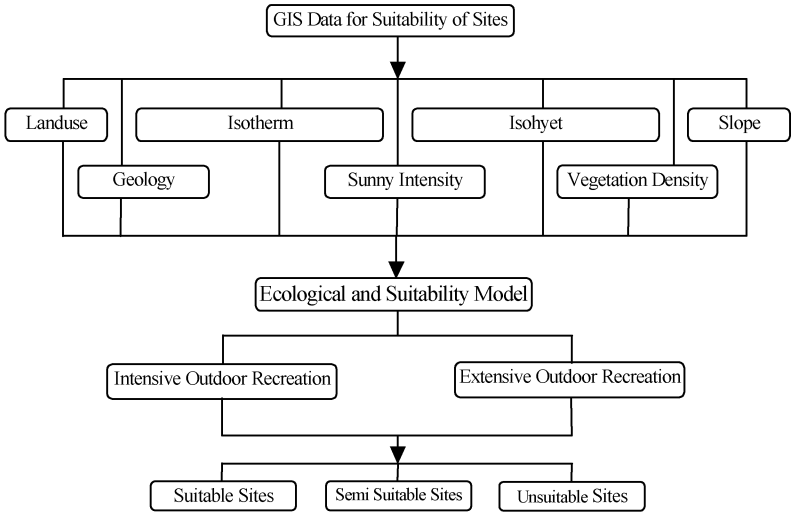

Fig. 2: Stages of study

MATERIALS AND METHODS

Present study conducted in Noshahr-Chalous County, Mazandaran province, Iran country locate in the southern part of Caspian Sea that its area calculated about '3404.7' km^2. It is located between 50° 54′ 66″ to 51° 56′ 19″ E and 36° 09′ 30″ to 36° 42′ 30″ N. This research carried out in the three regions (plain, middle land and mountain) that its elevation ranges from '48' to '4500'm above m.s.l. (Figure 1).

Satellite data (ETM sensor, landsat 7) are used to produce vegetation density map which is classified into three classes: density, semi density and without vegetation regions with regard to the frequency of cell of satellite data. Digital elevation model (DEM, resolution: 87×87m) is used to generate slope and sunny intensity (altitude: '65.07°', azimuth: '210°' for warm seasons)maps. The isohyet, isotherm and geology layers are as vector data used in this study (Figure 2).

Table 1: Ecological criterion for analysis

	Intensive outdoor recreation			Extensive outdoor recreation		
Ecological data	suitable	semi suitable	unsuitable	suitable	semi suitable	unsuitable
Slope	0-5	5-15	> 15	0-25	25-50	> 50
Geology	resistant	semi resistant	non resistant	resistant	semi resistant	non resistant
Vegetation density	semi density	density	without vegetation	semi density	density	without vegetation
Mean of precipitation in warm seasons	15-50	30-65	40-85	15-50	30-65	40-85
Mean of temperature in warm seasons	15-18.5	17-19	18-20	15-18.5	17-19	18-20
Sunny intensity	-	-	-	low	high	high
Landuse	pasture	forest	agronomic and residential	pasture	forest	agronomicandresidential

Tourism ecological model is used for suitability of sites. This model is divided into two extensive and intensive ecological model, which each of them are divided into three classification of suitable, semi suitable and unsuitable. The main criterion of ecological model has been proposed with regard to the natural condition of Noshahr-Chalous (Table 1).

First, the necessary layers are produced based on criterion and by GIS then, the desired sites are identified by suitability modeling and algebra syntax method and then their area are calculated. Finally, the results controlled via satellite data. The results suggested a good fit of sites with the land condition.

RESULT

To identify intensive suitable sites are used isotherms ('15' to '18.5' °C) and isohyet ('15' to '50' mm). The low sunny intensity and slope are considered as suitable sites, because the high sunny intensity and steep slope can be as inconvenience for ecotourist in warm seasons. In this method, geological resistant layer is selected for intensive suitable sites. The semi density vegetation is as a good condition for suitable sites. Eventually, '863' sites are identified, then, their areas estimated to be equal to '816.5' hectares. In contrast, to identify intensive semi suitable sites of outdoor recreation

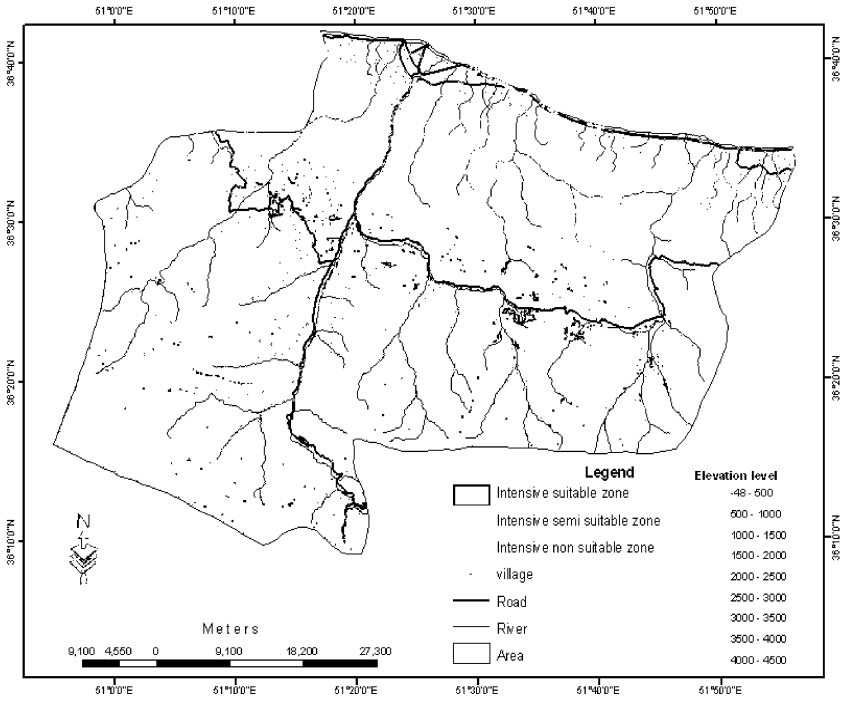

Fig. 3: Ecotourist model of relevance to intensive outdoor recreation sites

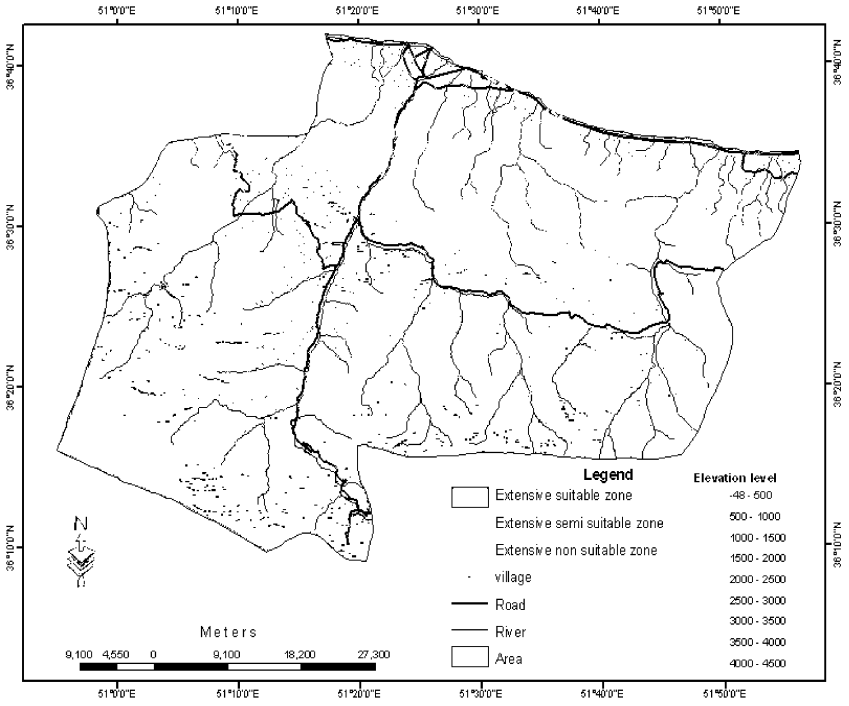

Fig. 4: Ecotourist model of relevance to extensive outdoor recreation sites

are considered the isotherms ('17' to '19'°C) and Isohyet ('30' to '65' mm) and sedimentary rocks. According to ecological model is selected slope layer to determine accurately. Also, to identify of semi suitable sites the vegetation density layer is used, then, we have identified '2296' sites and their area are calculated about '10465.7' hectares.

To identify unsuitability sites we have used temperature and precipitation climatic parameters, slope and non resistant sedimentary deposits of geological layer based on the ecological model. Here, isotherms and isohyet layers have a value of '18' to '20'°C and '40' to '85' mm, respectively. As well as the value of density of vegetation are similar to semi suitable sites, which '86' sites are found and their area calculated about '13.9' hectares. It is safe to say that did not use sunny intensity layer for intensive outdoor recreation. (Figure 3).

The climatic components of extensive outdoor recreation for suitable sites are similar to intensive suitable sites and the slope value is similar according to ecological model. The geological layer is included resistant textures, which it is similar to that of intensive suitable values because it is desirable as achievement ways. Totally, '548' sites are identified and their area calculated about '235.2' hectares.

The climatic data, like semi suitable of intensive outdoor recreation is used to determine the semi suitable sites of extensive outdoor recreation. The sedimentary rocks of geological layer has similar trait to that of intensive semi suitable and the slope value has similar status to ecological model too. Finally, '1759' sites are identified and their area calculated about '16843.5' hectares. To identify unsuitable sites is used the value of slope layer more than '50%'. Other data are based on table of ecological modeling. Hence we found '20' sites and their area calculated about '3' hectares (Figure 4).

DISCUSSION

According to the results of research on the extensive and intensive outdoor recreation basis on three classes (suitable, semi suitable and unsuitable) we have identified '5455' and '2327' sites that their area are estimated to be equal to '11296.1' and '17081.7' hectares, respectively. The suitable sites for each outdoor recreation type are located in mountainous region of Noshahr-Chalous. In the other words, this region can provide a favorite vegetation-climatic condition in warm seasons for ecotourist. We have used only six layers to identifying intensive outdoor recreation sites. For this reason, the values and area of sites have increased in relation to extensive suitable sites. After that analysed by GIS indeed, most of sites are located in the center of region especially along western-

eastern and around the road. Likewise, the semi suitable sites of extensive and intensive outdoor recreation are located in middle lands. But the distributions of extensive sites in middle regions are more homogeneous in relation to intensive sites because the percent of slope of extensive sites is more than intensive sites. But, the value of intensive semi suitable sites are more than other sites because of sunny intensity layer did not use in suitability, partly due to a lack of the presence of ecotourist for the long time (more than one day) and human welfare in study area. The unsuitable sites are located in plain regions, which it has undesirable climatic condition in warm seasons (hot and humid). Generally, the value of unsuitable sites are less than other classes. Therefore, Kumari *et al*. (2002) and Fung and Marfa (2002) recommended to use GIS for the identification of ecotourism resources. They identified the potential of ecotourist sites via ecotourism methods and GIS technique also emphasized to the role of mentioned system that it reduces the time and cost. Eventually the suitable sites of extensive and intensive outdoor recreation identified based on ecological criterion and conformed to natural conditions.

ACKNOWLEDGEMENT

Thanks to research assistance of Islamic Azad University, Chalous branch, for the financial support.

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